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NOTE ON PROFESSOR GRAZIANI'S ECONOMIC THEORY OF MACHINERY.

The theory of machinery, regarded as a branch of mechanics, has been exhaustively handled by competent writers, while the history of its introduction has been so often repeated that the names of successful inventors, from Watts and Fulton to Bell and Edison, have become as familiar as those of popular statesmen and warriors. The author of the little book* now before us neglects, however, these dramatic aspects of the subject, and directs his inquiries to the question of the place of machinery in economic theory. In turning to this more difficult, but not less useful study, he deserves the thanks of all economists.

The effects of machinery on the constitution of society, and on the distribution of wealth—these are the leading thoughts in Prof. Graziani's mind. He begins by distinguishing between tools and machines.

He believes that tools originated in the adaptation of the instruments of war to the purposes of peace. This is a plausible hypothesis, at least, although it may not be susceptible of proof that at that early day civilization began by a beating of swords into ploughshares and spears into pruning hooks. It is certain, however, that the use of tools was the first step out of barbarism, prior even to the domestication of animals, and that with the help of tools and of animals a very high degree of civilization was possible, long before machinery attained that predominant position which is the distinctive note of modern industrial society. But in spite of the high development of political institutions and the expansion of intellectual activity, society seemed to be irretrievably divided into classes, of which the more numerous were, by no fault of their own, but, as it seemed, by the very

* *Studii sulla Teoria Economica delle Macchine* by A. Graziani, pp. 115. Turin: Fratelli Bocca.

nature of things, hopelessly bound down to the soil or to the bench. There seemed to be no possibility that to them, also, Providence might vouchsafe some better lot than the scant sufficiency required to maintain life and to raise children.

Prof. Graziani is therefore well within the truth when he declares : " Tools were without doubt the chief cause of social progress, but they have not influenced the relative condition of the various classes : machinery, on the other hand, has extended its effects over the distribution of power and of the returns of production between the different classes of producers." (p. 8.)

Prof. Graziani recognizes that it is no easy matter to find a definition which will serve in an entirely satisfactory manner to distinguish between tools and machinery, and he therefore contents himself with commenting on the more striking peculiarities which distinguish them. "A tool," he says, " is a simple instrument which man directs to the transformation of matter ; a machine is a combination of mechanical powers which intervenes between man and nature, which receives from him a simple impulse, and, as it were, by its own virtue transforms material into product." (p. 10.)

The efficacy and the extended use of machinery are mainly dependent upon the possession of an abundant source of power, and among all such sources of power, steam, of course, is pre-eminent. Prof. Graziani states that so long ago as 1860, the amount of 1,800,000 horse-power was used to move machinery in England, without counting that engaged in supplying the means of transportation.

This amount is now greatly augmented ; and in view of so mighty an auxiliary force co-operating with man, what wonder that his mastery over nature should grow, and that a change amounting to little less than a revolution should ensue in the economic order of society !

The most important portion, however, of Prof. Graziani's book, in its relations to economic theory, is that in which he treats of the economic conditions, upon the existence of which the introduction of machinery depends.

"As manual labor preserves a field to itself in which machinery cannot compete with it, so machinery has a sphere which manual labor cannot invade. Outside of this circle [sic !], in which but a single productive system is possible, there remains a large territory open to either, and there machinery is of advantage when it increases the quantity of the product or improves its quality." (pp. 30, 31.) Our author tells us, further, how the decision is made. "Since, in the modern system of industry, production is directed by the undertaker, the application of more or of less auxiliary capital depends upon his interest." * * * "It may happen that the rate of wages is so low as to render it more suitable to conduct the enterprise by the use of manual labor than by the use of machinery; it may happen, on the other hand, that the rate of wages may be so high as to render the use of machinery more advantageous." (p. 19.)

This thought is most fully developed in the third chapter. Our author there begins by critically examining the teachings of v. Thünen, "the first," he says, "who, with the insight of genius and with fixity of purpose, treated expressly the relative applicability of auxiliary capital and of remuneratory or wages capital." (p. 52.)*

"According to v. Thünen, auxiliary capital can be advantageously substituted for wages capital whenever the interest on the auxiliary capital is less in amount than the wages, but not when it is equal or superior; so that, other things being equal, a less rate of interest favors the substitution of auxiliary capital for wages capital." * * * "But this statement cannot stand, in face of an attentive examination." * * * "It is not the interest on auxiliary capital which is to be compared with wages, but the loss of value which auxiliary capital incurs in use is to be added to the profit on the whole of the auxiliary capital, and this total is to be compared with the whole amount of the wages capital added

* In what follows, it will be noticed that Prof. Graziani speaks of auxiliary capital as though it were identical with machinery. It, of course, in reality includes not only machinery, but a great many other things as well.

to the profit to which it would be entitled." * * * "If a machine were to be completely worn out in one year, as is the case with wages capital, v. Thünen's error would be so evident as to need no answer. It would, in fact, follow from this supposition that if the rate of interest were ten per cent., there would be an advantage in substituting a machine worth ten thousand *lire* for wages capital of eight thousand *lire*, because the interest of ten thousand *lire* being one thousand *lire*, is less than eight thousand *lire*! But the doctrine is just as false when the auxiliary capital is but slowly consumed. Let us suppose a machine to have the value of twenty thousand *lire*, and that it is substituted for a wages capital of two thousand *lire*; let us suppose the rate of profit to be the same as that of interest, and that it is ten per cent., and, further, that the duration of the machine is such that the annual loss in value is two thousand *lire*."

"According to v. Thünen's theory, when the interest of twenty thousand *lire*, the value of the auxiliary capital, is equal to the two thousand *lire*, the amount of the wages, there will be neither loss nor gain in employing machinery, there being no increase of cost in doing so. But, as a matter of fact, things turn out in the following manner. In order that the enterprise should be profitable, it is necessary, when manual labor is employed, that the product should return to the undertaker the two thousand *lire* of wages which he has paid, and, in addition, a profit of ten per cent., or, in all, twenty-two hundred *lire*. On the other hand, if the labor of the machine is employed, the product must make good to the undertaker the loss of two thousand *lire* on his capital *plus* the profit on his entire capital of twenty thousand *lire*, making in all four thousand *lire*. It is, therefore, clear in this case that the use of machinery would involve a notable increase of cost." (pp. 55, 56, 57.)

Prof. Graziani evidently means to imply that v. Thünen was really ignorant of the existence of wear and tear, and that it was reserved for himself to discover it. If this view is

correct, it is at least difficult to reconcile it with Graziani's own estimate of v. Thünen as a "profound thinker."

After disposing of v. Thünen, Prof. Graziani turns somewhat contemptuously upon me because it so happens that in some essays which I once wrote on the subject of the law of wages, I was led to touch incidentally upon the same topic, which he treats of here. Prof. Graziani, it seems, thinks that the views I there expressed were copied by me from v. Thünen.

"Nevertheless," he says, "in spite of this absurd consequence to which it leads, the doctrine of Thünen, in its most absolute form, has recently been maintained by an American economist, Stuart Wood, who presents it without any too much novelty of reasoning. He says that there are operations in which the superiority of mechanical labor over manual labor is manifest, and that there are others in which the superiority of the latter is equally incontestable, but that in certain other undertakings either machines or manual labor can be substituted the one for the other. Now, according to Stuart Wood, in these latter cases the choice of the capitalist depends upon the relative cost of these different methods of production, and this is measured by the rate of interest on auxiliary capital compared with the wages of the laborers; but the amount which is paid as interest cannot differ greatly from that which is paid as wages, because machinery and labor are able to replace each the other, and, therefore, the law of competition imposes the equality of their compensation.

"The same objections which we have raised against v. Thünen are valid against Stuart Wood, and we shall not stop to repeat them."* (pp. 57-58.)

It seems from the foregoing passages that v. Thünen and myself are charged in one indictment with having overlooked the element of wear and tear in estimating the comparative

* I shall not pause to criticise this statement of my views further than to mention that I have always endeavored to avoid speaking of machinery as commensurate with auxiliary capital, as Graziani frequently does, and in the passage here quoted represents me as also doing.

costs of using capital and of using labor, and I am further accused with having borrowed v. Thünen's doctrine without acknowledging my obligation to him. In short, it is alleged that not only is my doctrine erroneous, but that my very error is not my own, but surreptitiously purloined from another.

Let those who enjoy such discussions compare the language here attributed to me with the language used by Graziani to express his own views and quoted above (see page 92, lines 1 to 16). As I do not pretend to rival the learned professor in erudition, I confess, without a pang, that I had never seen a copy of v. Thünen's work until after reading Graziani's, so that I could have as little borrowed my views from one as from the other. Indeed, v. Thünen's name was little known in America until attention was recently directed to his writings by Prof. Marshall.

I do not know what v. Thünen would have answered to Graziani's objections. It is quite possible that he may have been perfectly conscious of the influence of wear and tear, and that he may have thought it so self-evident as to require no mention for the special purposes of his investigation. It is even possible that he may have thought that no one could fail to perceive it, and so would not have begrimed its discovery to Graziani.

As for myself, although the special subject of my study did not require me to do so, I nevertheless did explicitly refer to the very facts which Prof. Graziani charges me with ignoring, and I do so in the very article from which he quotes.

"The principal element of the cost of using capital is interest: Interest alone is really paid as compensation for its use. But interest is by no means the only element of cost. In order to keep it intact and provide against sudden loss or gradual depreciation, there must be provided, in addition to interest, a fund for insurance and renewals, or wear and tear. These things vary greatly with the nature of the particular business; while interest, strictly speaking, does

not so vary. And besides insurance against loss by sudden destruction or by the dilapidation of gradual wear and tear, there must be an insurance provided against the possible depreciation in value arising out of the instability of business and its changing conditions. Labor is therefore often employed at a price far exceeding the ordinary interest on the amount of the capital which could replace it. The owner of a silver mine for these reasons may sometimes wisely hesitate to erect labor-saving appliances, even at an annual saving of from thirty to fifty per cent. on their cost; while a prudent manufacturer will often pass by opportunities to save ten per cent., or even twenty per cent. on the cost of improvements which it is in his power to make.

"But the charges for insurance and for renewals, or for wear and tear, are not strictly charges for the use of capital, but simply a provision to preserve its amount unimpaired. Excluding these charges from the cost of using capital, its interest remains as the compensation for its use, and is equal in all its employments at the same time and place."*

In comparing with this passage the objections so far adduced by Graziani, one might suppose his opinion to be identical with my own. But, no; he objects to making the rate of interest the basis of the comparison between the cost of using auxiliary capital and the cost of using labor. He prefers to make the rate of profit rather than the rate of interest fill that rôle, and in this he supposes that he is introducing a notable change. I do not know what may be Prof. Graziani's theory of profit, but I do know that all careful thinkers on this subject are agreed that profit consists of the three elements, interest, insurance and wages of superintendence. Of these, the first only bears any fixed ratio to the amount of capital employed. The wages of superintendence cannot in any way affect the undertaker's choice between the use of auxiliary capital and the use of labor. Insurance, of course, does affect this determination much as wear and tear do, and for that reason I have treated it like them in the

* Stuart Wood in *Quarterly Journal of Economics*, October, 1888, p. 70.

passage quoted above. Insurance and wages of superintendence being thus eliminated, there remains interest only.

As one great error brings other lesser errors in its train, so Professor Graziani imputes to me two other lesser blunders. The first is that I fail to avoid a certain ambiguity alleged to lurk in the word "rate." "By the rate of interest, is meant the relation between the returns of a capital and the capital itself; by the rate of wages, on the other hand, is meant not the relation between a capital and its return, but the actual compensation of each laborer; so that the rate of interest and the rate of wages, apparently analogous phenomena, assume a heterogeneous nature." (p. 58.) This distinction is familiar to me. If I have ever forgotten it with the result of vitiating my reasoning, I would be thankful to have the place pointed out in which I do so.

The second of the minor faults imputed to me, is my alleged failure to observe that the capital used in paying wages must receive interest, just the same as auxiliary capital does, and at the same rate. "The rate of interest on auxiliary capital and the rate of interest on wages capital must be identical, because the competition of capital prevents any divergency, so that the rate of interest will not of itself have any influence on the choice between employing capital in one way or the other. (p. 59.) If this were so, by substituting the word "profit" for the word "interest," the same reasoning would destroy Prof. Graziani's theory that the choice between auxiliary capital and labor is determined by the rate of profit (plus wear and tear), instead of by the rate of interest. His ardor, however, to confute the supposed errors of others has led him into the very palpable error of confusing the amount of interest with the rate of interest. That he knows better is proved by the fact that he elsewhere (p. 57), as already quoted, himself adduces the instance of a machine worth twenty thousand *lire*, supplanting labor which requires a wage capital of two thousand *lire*, and himself draws the inference that if interest or profit be at the rate of ten per cent., it will amount to two thousand *lire* in the case of

the machine, and two hundred *lire* in the case of wages capital.

I have dwelt at length on these passages, not merely because they concern me personally, but also, because I believe that Prof. Graziani's statements tend to introduce fresh confusion into a difficult subject, instead of clearing up that which already prevails.

The opinions expressed in his book, are, for the most part, sound and judicious, and the errors into which the author has fallen are due not so much to any fundamental vice in his system as to the fact that his eagerness for controversy causes him to attempt to refute the statements of others before he has attained a clear insight into their real meaning.

STUART WOOD.

Philadelphia, Pa.